

REMARKS

Claims 1-31 are pending in this application. Claims 1-31 stand rejected. Claim 58 has been added. Support for the new claim can be found beginning on page 6 line 20 through page 9 line 5 and elsewhere in the specification. Claims 1-31 and 58 remain in the application. Applicant respectfully traverses the rejections for the reasons expressed herein below.

A. Rejection of Claims 1-2, 5 and 14-15 under 35 U.S.C. § 103(a)

Claims 1-2, 5 and 14-15 stand rejected under 35 U.S.C. § 103(a) as being obvious, and therefore unpatentable, over United States Patent No. 5, 807,785, issued to Ravi ("Ravi") in view of United States Patent No. 6,184,158, issued to Shufflebotham et al. ("Shufflebotham"). Applicant respectfully traverses this rejection and requests reconsideration of claims 1-2, 5, and 14-15.

Claims 1-2, 5 and 14-15 recite a method of forming dielectric layer in an opening having an aspect ratio of greater than about two. A first dielectric layer is formed in the opening at a first deposition rate wherein a portion of the opening not filled with the first dielectric layer has an aspect ratio of not greater than about two. A second dielectric layer is formed at a second deposition rate greater than the first deposition rate over the first layer, filling the portion of the opening not filled with the first dielectric layer, and has a top surface that is not within the opening such that voids are not substantially present in the opening.

Ravi discloses a low dielectric constant silicon dioxide sandwich layer. As stated from column 8, line 56 to column 10, line 60, the Ravi sandwich layer comprises a first

layer and a second layer. The first layer is formed using a plasma-enhanced chemical vapor deposition (PECVD) process that partially fills a narrow gap between conductive lines. The second layer is formed over the first layer using a subatmospheric chemical vapor deposition (SACVD) process. As stated in column 2, lines 28-32, Ravi discusses that, as conventionally known in the art, a SACVD layer (the second layer of Ravi) is formed using a relatively slow deposition rate and a PECVD layer (the first layer of Ravi) is deposited "more quickly".

Shufflebotham teaches a process for filling gaps between electrically conductive lines on a semiconductor substrate that employs an inductively coupled plasma-enhanced chemical vapor deposition (IC PECVD) high density plasma system. As noted by the Examiner, Shufflebotham teaches growing a first dielectric film in the gaps at a first deposition rate, and depositing a capping layer comprising a second dielectric film at a second deposition rate that is higher than the first deposition rate.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the combination of prior art. MPEP §2143.03. In addition, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. MPEP §2143. Put another way, the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination or modification. MPEP §2143.01. In addition, it must be remembered that that a prior art reference must be considered in its entirety, i.e., as a

whole, including portions that would lead away from the claimed invention. MPEP §2143.02

Unlike claims 1-2, 5, and 14-15 of the present invention, and as acknowledged by the Examiner, Ravi does not teach a first dielectric layer formed at a first deposition rate or a second dielectric layer formed at a second deposition rate greater than the first deposition rate. In contrast to recited claims 1-2, 5, and 14-15, Ravi teaches deposition rates that are directly opposite the deposition rates recited in the claims. The Examiner asserts that Shufflebotham may be combined with Ravi, as Shufflebotham teaches depositing a second dielectric layer at a second deposition rate greater than the first deposition rate.

It is respectfully submitted that the teachings of Ravi and those of Shufflebotham are not properly combinable, as asserted by the Examiner, and that because Ravi teaches away from the present invention, Ravi can not combined with Shufflebotham to render obvious the claims of the present invention. Accordingly, it is respectfully submitted that the PTO has failed to establish *prima facie* obviousness of a claimed invention.

As discussed above, Ravi teaches a deposition process that is directly opposite the teachings of Shufflebotham. Ravi teaches that the second layer, being a SACVD layer, must be deposited at a deposition rate that is “relatively slow” as compared to the first layer (See col. 2, lines 17-34). Because Ravi teaches a first layer that is deposited at a relatively quick deposition rate and a second layer that is deposited at a relatively slow deposition rate, i.e. directly opposite the deposition rates of Shufflebotham, one of skill in the art would not combine the teaching of Shufflebotham with Ravi, and no

motivation or suggestion exists to do so. Indeed, one of ordinary skill in the art reading Ravi would be encouraged to apply the dielectric layers at rates opposite those claimed in Shufflebotham. Accordingly, Ravi and Shufflebotham are not properly combinable to establish *prima facie* obviousness.

Furthermore, Applicant submits that Ravi would lead one of ordinary skill in the art away from the teachings of the recited claims. Indeed, by teaching the application of deposition rates that are opposite the claimed invention, Ravi can be said to teach away from the claimed invention. Otherwise, a clearly stated objective in Ravi of filling gaps in metal layers would not be achieved. It is submitted that because Ravi teaches away from the present invention, the combination of Ravi and Shufflebotham can not be made and can not teach each and every element of the present invention or render obvious the claims of the present invention.

Accordingly, withdrawal of the rejection of claims 1-2, 5, and 14-15 under 35 U.S.C. § 103(a) over Ravi in view of Shufflebotham is respectfully requested.

B. Rejection of Claims 3, 7-8, 16-19, and 20-25 over Ravi and Shufflebotham in view of Kocmanek

Claims 3, 7-8, 16-19, and 20-25 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ravi and Shufflebotham as applied to claims 1-2, 5 and 14-15 and further in view of United States Patent No. 5,252,520 issued to Kocmanek et al. ("Kocmanek"). Applicant respectfully traverses this rejection and requests reconsideration of claims 3, 7-8, 16-19, and 20-25.

Claims 3, 7-8, 16-19, and 20-25 recite a method for forming a dielectric layer on a substrate including forming a first dielectric layer at one process setting and forming a second dielectric layer at a second process setting and, wherein, the deposition rate for the second dielectric layer is greater than the deposition rate for the first dielectric layer. Process variables that may be adjusted include temperature, pressure, dopant concentration, flow rate and shower head spacing.

Kocmanek teaches a method for forming a multi-layer dielectric such that the initial film density of the deposited dielectric is higher than or equal to that of the bulk of the first and second dielectric. This is accomplished by altering the process settings, specifically by reducing the flow rate of the precursor gas during the initial portion of the deposition process relative to the flow rate during the remainder of the deposition process. As set forth in column 1, lines 40-55, the process variation is particularly directed to formation of portions of the second dielectric layer.

For the reasons discussed above that distinguish claims 1-2, 5, and 14-15 of the present invention from the teachings of Ravi and Shufflebotham, the Applicant respectfully asserts that claims 3, 7-8, 16-19, and 20-25 are also clearly distinguishable from the teachings of Ravi and Shufflebotham. Further, it is submitted that nothing in Kocmanek, together with Ravi and Shufflebotham, teaches or suggests claims 3, 7-8, 16-19, and 20-25 of the present invention. Indeed, the Examiner relies on Kucmanek for the limited teaching of disclosing the application of various process settings during deposition.

Accordingly, withdrawal of the rejection of claims 3, 7-8, 16-19, and 20-25 under 35 U.S.C. § 103(a) over Ravi and Shufflebotham in view of Kocmanek is respectfully requested.

C. Rejection of Claim 4 over Ravi and Shufflebotham in view of Chou

Claim 4 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ravi and Shufflebotham as applied to claims 1-2, 5, and 14-15, and further in view of U.S. Patent No. 5,861,345 issued to Chou et al ("Chou"). Applicant respectfully traverses this rejection and requests reconsideration of claim 4.

Chou teaches an *in situ* inter-dielectric process for forming multilevel metal structures on a semiconductor. The method comprises forming an SOG layer on an uneven semiconductor surface, treating the surface of the SOG layer with plasma in a PECVD chamber, and forming a PECVD layer on the treated surface in the same PECVD chamber.

For the reasons discussed above, claim 4, which depends from claim 1, is clearly distinguishable from the teachings of Ravi and Shufflebotham. Further, nothing in Chou if combined with Ravi teaches or suggests the method recited in claim 4. Indeed, the Examiner relies on Chou for the limited teaching of a first dielectric layer having a top surface that is not within the opening.

Accordingly, withdrawal of the rejection of claim 4 under 35 U.S.C. § 103(a) over Ravi and Shufflebotham in combination with Chou is respectfully requested.

D. Rejection of Claim 26 over Ravi and Shufflebotham in view of Lin

Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ravi and Shufflebotham as applied to claims 1-2, 5, and 14-15 and further in view of U.S. Patent No. 5,969,409 issued to Lin ("Lin").

Claim 26 recites a method of forming a first dielectric layer in an opening at a first deposition rate completely filling the opening, the opening having an aspect ratio greater than about two, and forming a second and final dielectric layer at a second deposition rate greater than said first deposition rate over the first dielectric layer such that voids are substantially not present in the opening.

Lin teaches a wafer planarization process that combines a high-density plasma chemical vapor deposition (HDP-CVD) process with a chemical mechanical polishing (CMP) process. The process employs at least three dielectric layers to form the final semiconductor device.

For the reasons stated above that render claims 1-2, 5, and 14-15 clearly distinguishable from Ravi and Shufflebotham it is asserted that claim 26, which recites a similar method to claims 1-2, 5, and 14-15, is also clearly distinguishable from the teachings of Ravi and Shufflebotham. In addition, nothing in Lin, together with Ravi and Shufflebotham disclose a method recited in claim 26. Indeed, the Examiner only relies on Lin for the limited teaching of forming a dielectric layer completely filling the opening.

Accordingly, withdrawal of the rejection of claim 26 under 35 U.S.C. § 103(a) over Ravi and Shufflebotham in view of Lin is respectfully requested.

E. Rejection of Claims 6, 9-13, and 27-31 over Ravi and Shufflebotham in view of Jang

Claims 6, 9-13, and 27-31 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ravi and Shufflebotham as applied to claims 1-2, 5, and 14-15 and further in view of U.S. Patent No. 5,563,104 issued to Jang et al. ("Jang").

Claims 6, 9-13, which depend from claim 1, and claims 27-31 teach the formation of a dielectric layer wherein the first layer is formed at a first deposition rate and a first process setting and the second layer is formed at a second deposition rate greater than the first deposition rate and a second process setting having a predetermined relationship with the first process setting. The first process setting and the second process setting may be temperature, reactor chamber pressure, dopant concentration, flow rate and shower head spacing.

Jang teaches a three-step deposition process that includes a PECVD deposition step and a two-step low and high temperature ozone-TEOS process to form a three-layered integrated circuit.

For the reasons discussed above that distinguish claims 1-2, 5, and 14-15 of the present invention from the teachings of Ravi and Shufflebotham, Applicant asserts that claims 6, 9-13, and 27-31 which recite similar limitations for claims 1-2, 5, and 14-15, are also clearly distinguishable from Ravi and Shufflebotham. In addition, nothing in Jang when combined with Ravi and Shufflebotham, teaches or suggests the methods recited in claims 6, 9-13, and 27-31. Indeed, the Examiner only relies on Jang for the limited teaching of the ability to vary process settings during the formation of a multi-layered dielectric layer.

Accordingly, for at least the reasons discussed above, withdrawal of the rejection to claims 6, 9-13, and 27-31 under 35 U.S.C. § 103(a) over the combination of Ravi, Shufflebotham, and Jang is respectfully requested.

F. New Claim 58

New claim 58 has been added and is believed to be patentable over the prior art of record for the reasons discussed above. Accordingly, early allowance of new claim 58 is respectfully requested.


CONCLUSION

Applicant submits that claims 1-31 and 58 of the present invention recite a novel and non-obvious method of forming a dielectric layer. The cited references neither teach nor suggest the claimed method. In view of the foregoing, Applicant respectfully submits that the subject application is in condition for allowance. Accordingly, reconsideration of the rejections and allowance of the claims at an early date are earnestly solicited.

If the undersigned can be of assistance to the Examiner in addressing issues to advance the application to allowance, please contact the undersigned at the number set forth below.

Respectfully submitted,

Dec. 2, 2004
Date



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